2A.1 Sizing Gelant Treatments in Hydraulically Fractured Production Wells

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Abstract

Often, when production wells are stimulated by hydraulic fracturing, the fracture unintentionally breaks into water zones, causing substantially increased water production. To correct this problem, we developed an engineering basis for designing and sizing gelant treatments in hydraulically fractured production wells. In these treatments, gelant penetrates a short distance from the fracture face into the porous rock associated with both water and hydrocarbon zones. Success for a given treatment requires that the gel reduce permeability to water much more than that to hydrocarbon. We present a simple 11-step procedure for sizing these gelant treatments. This procedure was incorporated in user-friendly graphical-user-interface software than can be downloaded from our web site at http://baervan/ResSweepEffic/reservoir.htm.

Sizing Gelant Treatments in Hydraulically Fractured Production Wells

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- When production wells are stimulated by hydraulic fracturing, the fracture often extends into water.
- Gelant treatments can reduce water production.
- An engineering-based design method for gelant treatments can be found in *SPEPF* (Nov. 1998) 223-229 and in free software (Gel Design) from http://baervan.nmt.edu

SIZING GELANT TREATMENTS IN HYDRAULICALLY FRACTURED PRODUCTION WELLS

Previous designs have been strictly empirical:

- 1/2 to 1 day's production volume.
- Certain volume per foot of pay.
- Volume to achieve a certain radius from the well.

Need an engineering-based approach to sizing.

DESIGN PROCEDURES SHOULD VARY WITH THE TYPE OF PROBLEM BEING TREATED:

- Flow behind pipe.
- Unfractured wells where crossflow cannot occur.
- Unfractured wells where crossflow can occur.
- Hydraulically fractured wells.
- Wells in naturally fractured reservoirs.

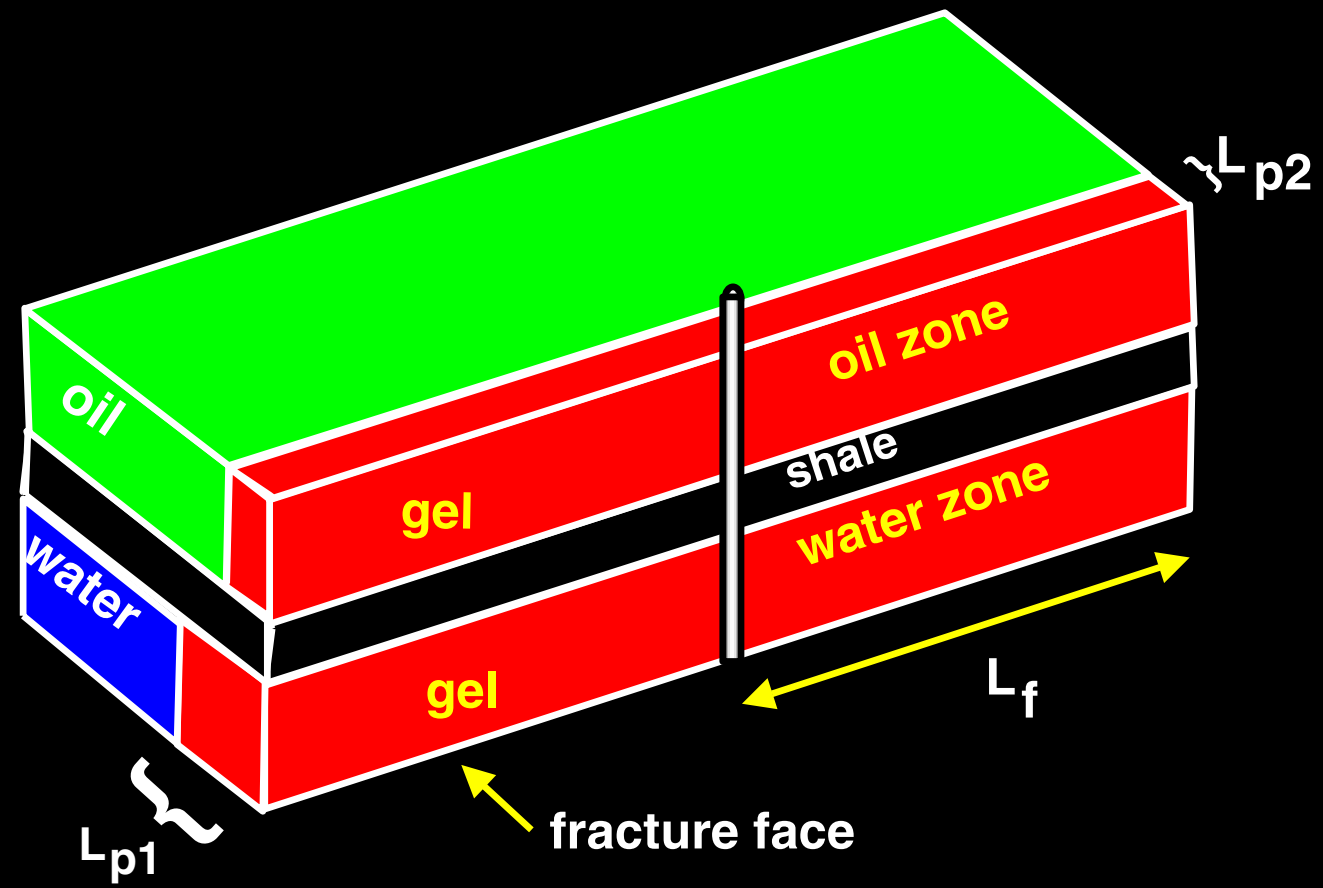
SIZING GELANT TREATMENTS IN HYDRAULICALLY FRACTURED PRODUCTION WELLS

Our design:

- is based on sound engineering concepts.
- involves a simple 11-step procedure.
- software is available for easy application.
- is specific to hydraulically fractured production wells.
- assumes that gelants are used.
- neglects the effects of gel in the fracture itself.

Objective: Reduce water entry into the fracture without significantly reducing oil productivity.

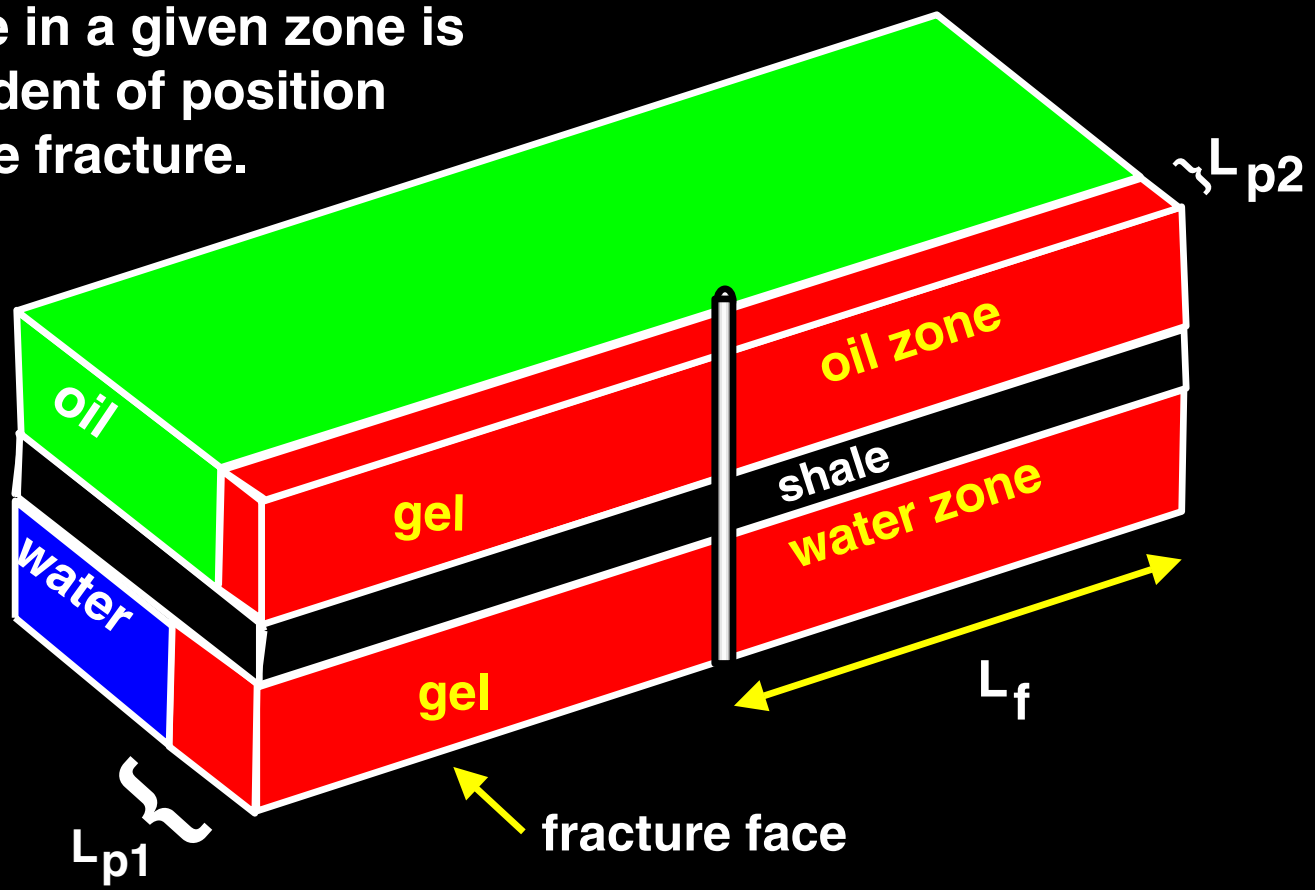
- Gelant flows rapidly along the fracture and leaks off a short distance into the porous rock in all fractured zones.
- Gel reduces permeability to water much more than that to oil.



Objective: Reduce water entry into the fracture without significantly reducing oil productivity.

METHOD ASSUMES:

- restriction to flow caused by gel in the porous rock is large compared to that caused by gel in the fracture.
- leakoff rate in a given zone is independent of position along the fracture.



SIZING GELANT TREATMENTS IN HYDRAULICALLY FRACTURED PRODUCTION WELLS

Documentation:

- *SPE Production & Facilities, Nov. 1998, 223-229.*
- *DOE Report DOE/PC/91008-4, 33-49 & 151-155.*

Software can be downloaded from:

- www.baervan.nmt.edu/ResSweepEffic/reservoir.htm.
- Push the "Gel Design" hot key for the download.
- Only works for PC's (Windows 95, 98, NT).

Program & Copyright Information

GelDesign Version 1.07

New Mexico Petroleum Recovery Research Center

Program Information

This program is for sizing treatments in hydraulically fractured production wells.

Contact Information

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Randy Seright (505) 835-5571

Continue

Exit

Candidate Selection Criteria

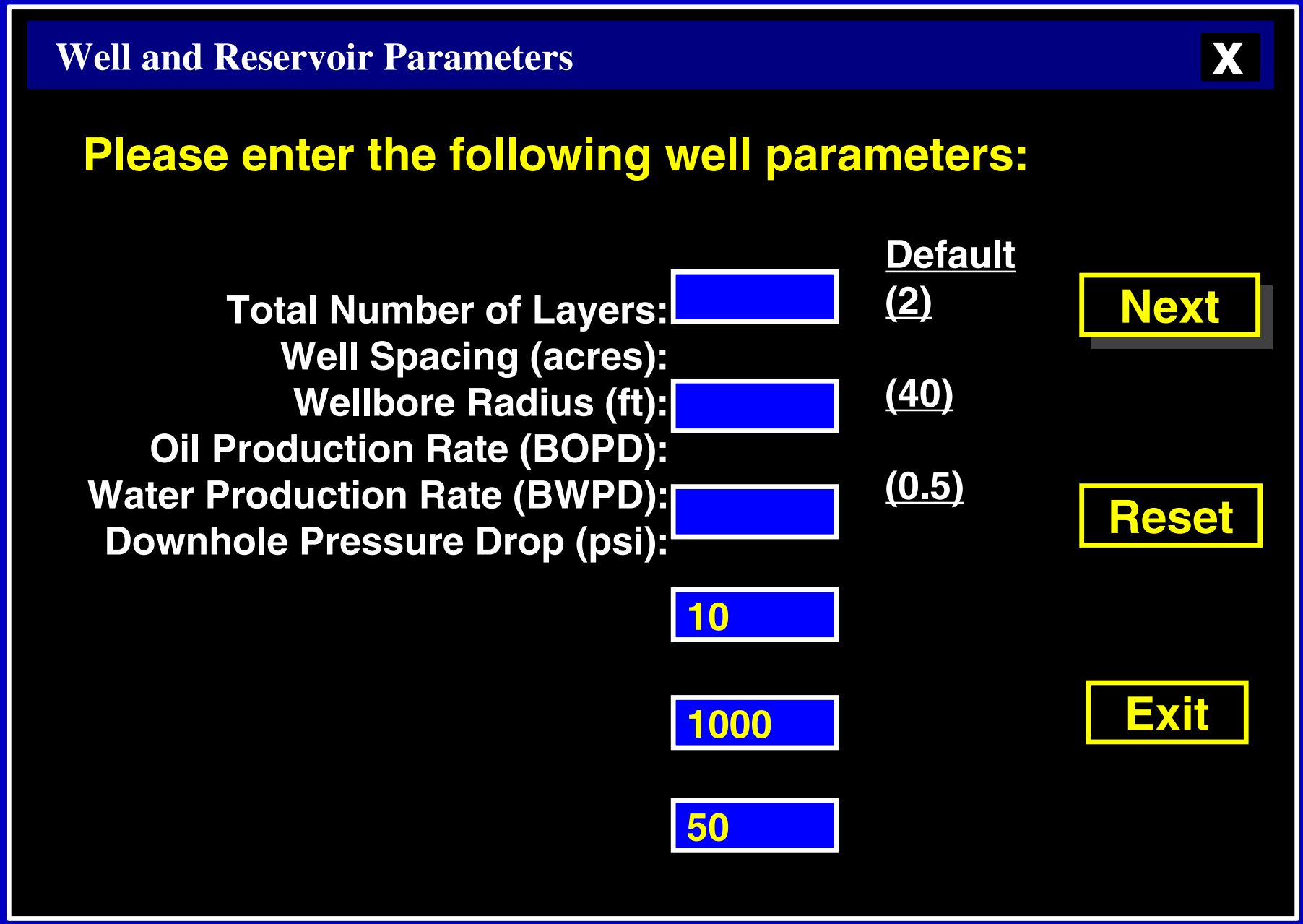
X

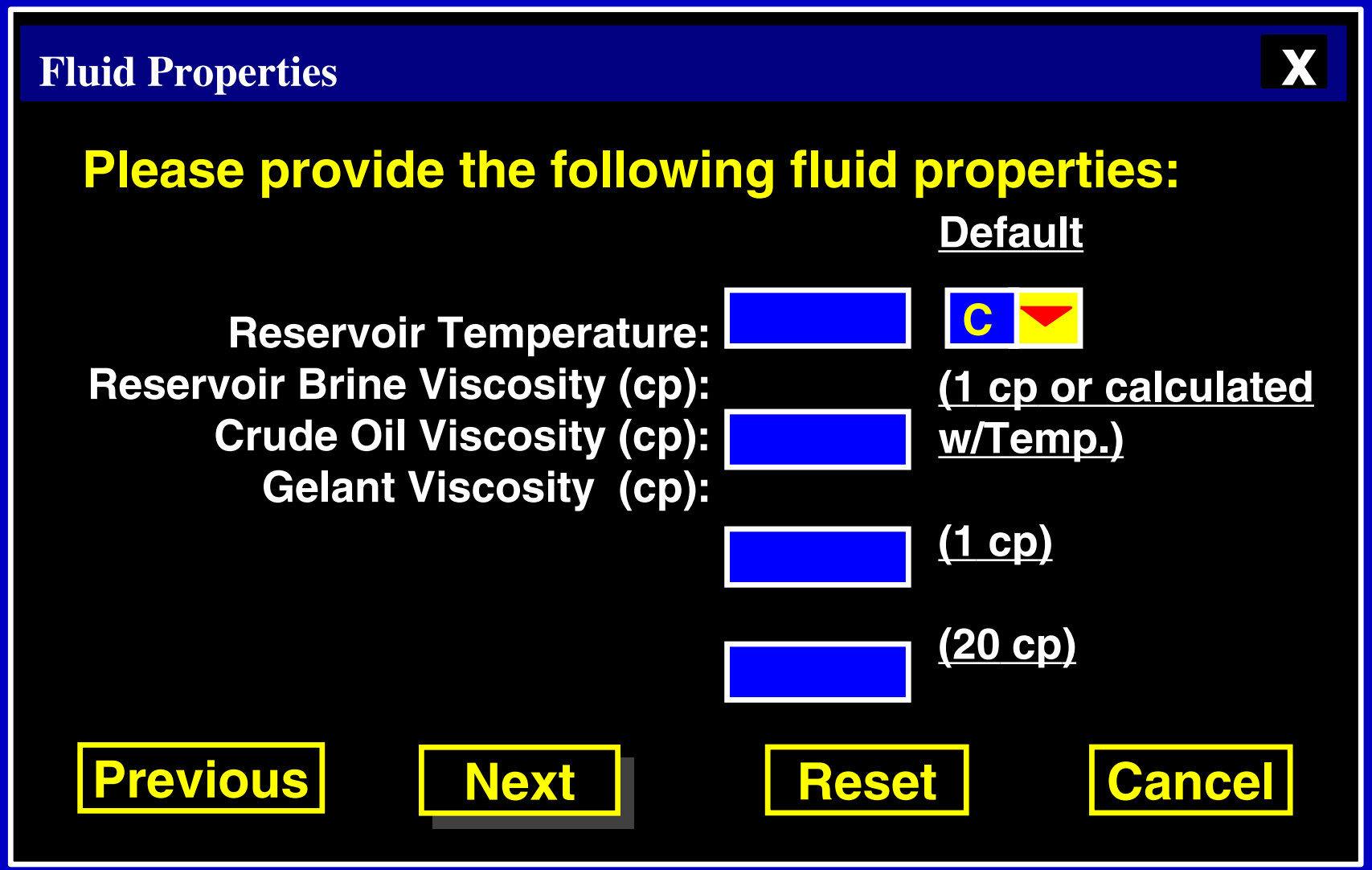
Candidate Selection Criteria
For Hydraulically Fractured Production Wells

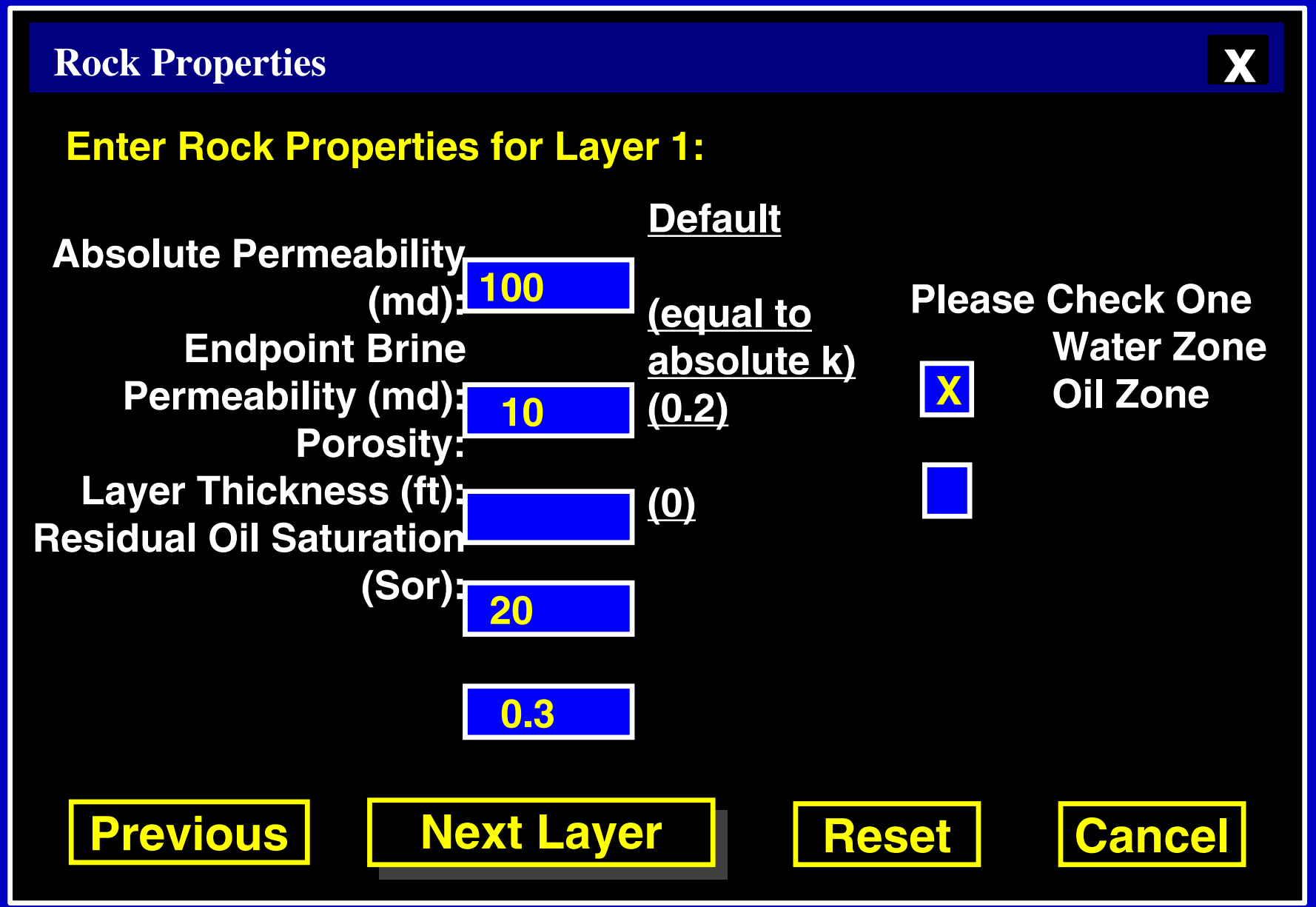
1. J/Jo is greater than 5.
   where:
   J is the actual well productivity.
   Jo is the productivity of an unfractured and undamaged well.
2. High WOR.
3. Fracture cuts through distinct water and hydrocarbon zones.
4. Barriers to vertical flow exist except in the fracture.
5. A satisfactory mobile oil target exists.

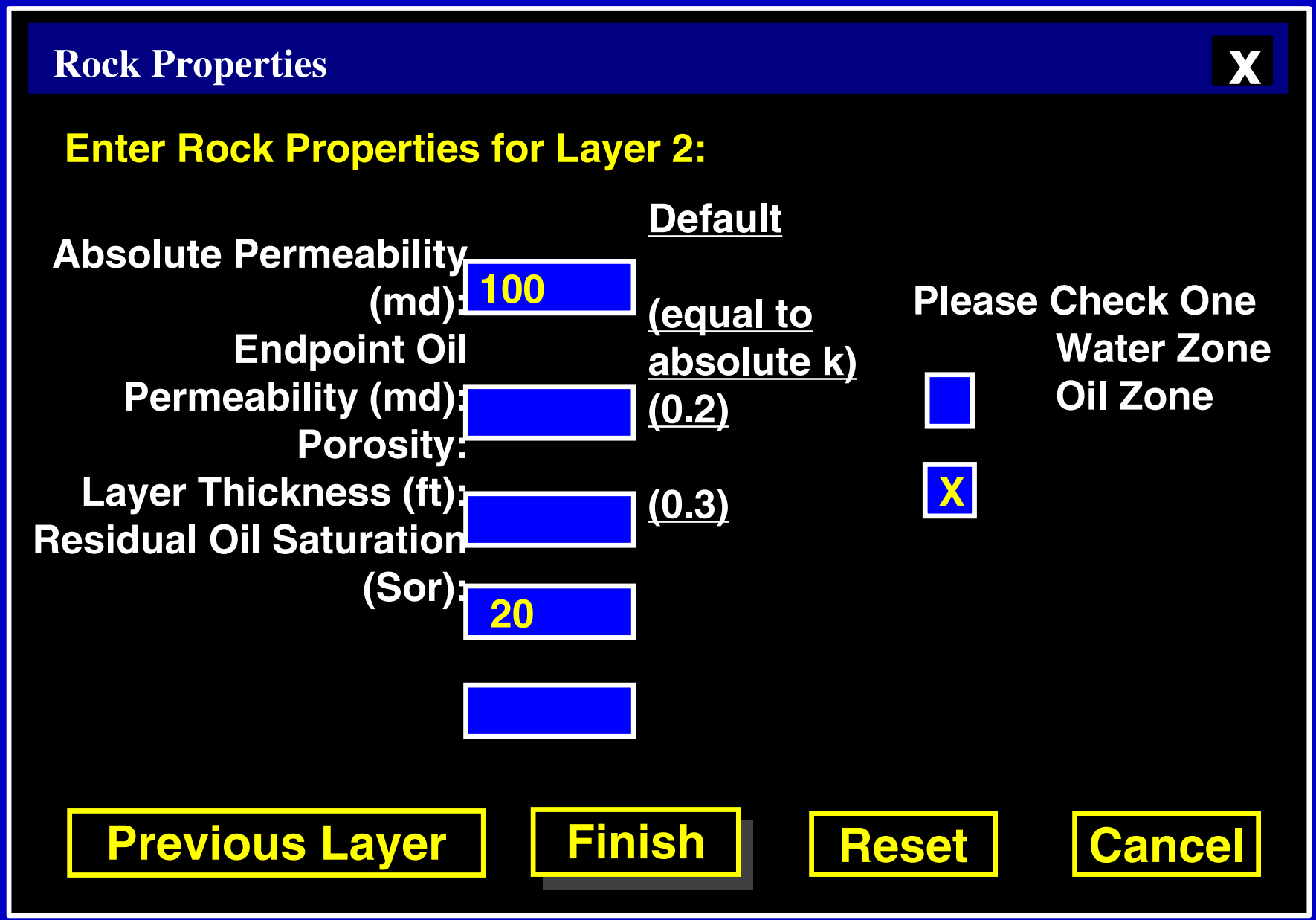
Continue

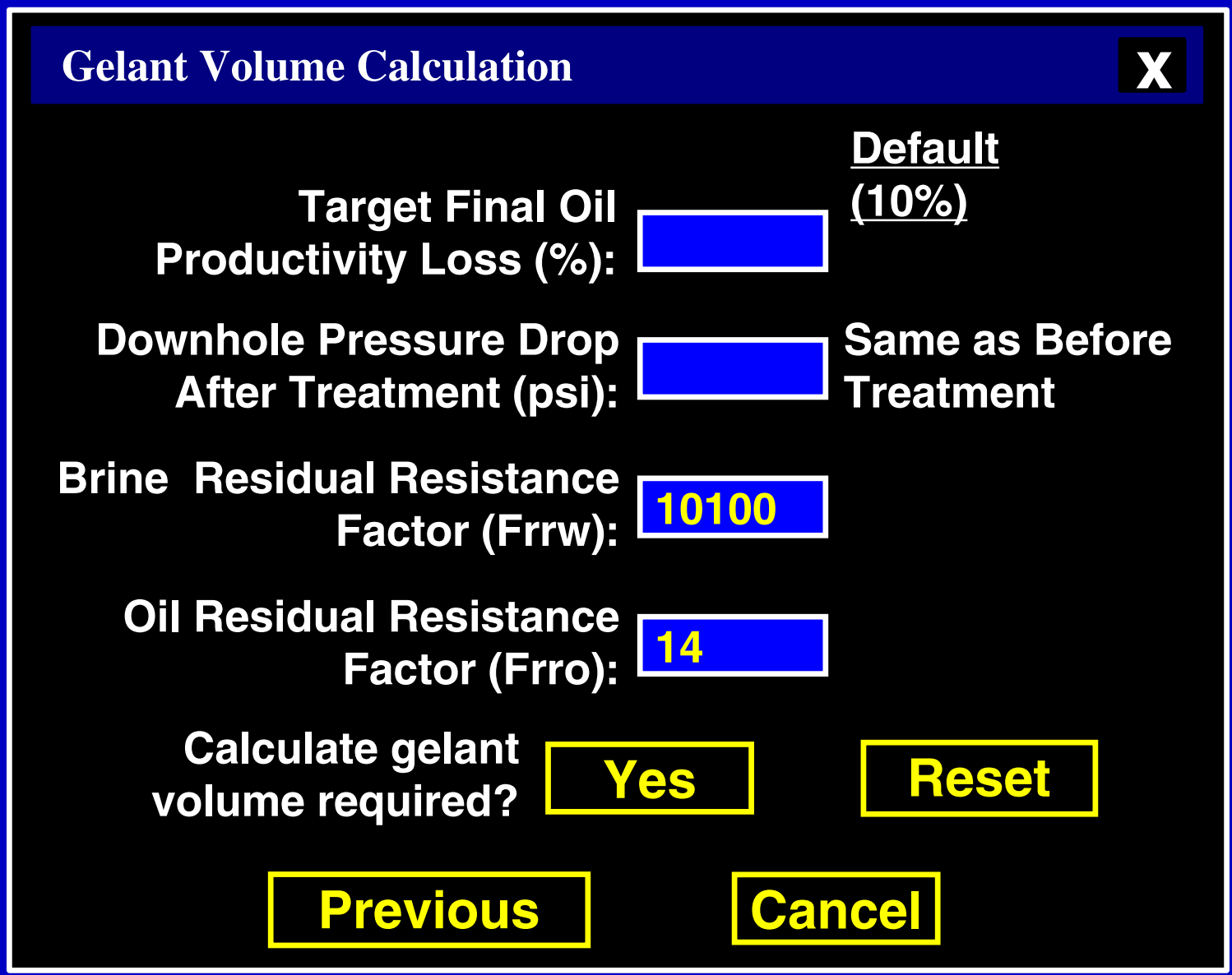
Exit

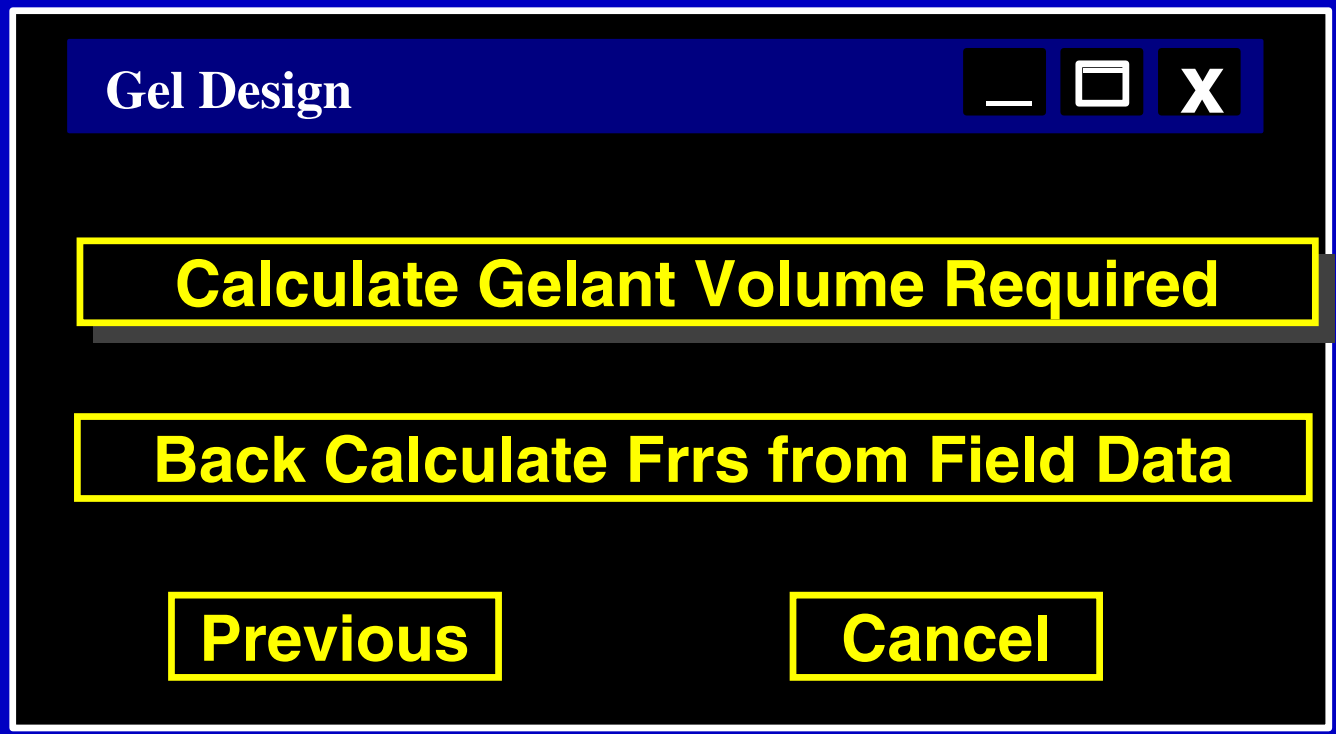

Well and Reservoir Parameters
X
Please enter the following well parameters:
Default
Total Number of Layers:
(2)
Next
Well Spacing (acres):
Wellbore Radius (ft):
(40)
Oil Production Rate (BOPD):
Water Production Rate (BWPD):
(0.5)
Reset
Downhole Pressure Drop (psi):
10
1000
Exit
50


Fluid Properties
X
Please provide the following fluid properties:
Default
Reservoir Temperature:
C
Reservoir Brine Viscosity (cp):
(1 cp or calculated w/Temp.)
Crude Oil Viscosity (cp):
Gelant Viscosity (cp):
(1 cp)
(20 cp)
Previous
Next
Reset
Cancel


Rock Properties
X
Enter Rock Properties for Layer 1:
Default
Absolute Permeability (md):
100
(equal to absolute k)
Endpoint Brine Permeability (md):
10
(0.2)
Porosity:
Layer Thickness (ft):
(0)
Residual Oil Saturation (Sor):
20
0.3
Please Check One
Water Zone
Oil Zone
X
Previous
Next Layer
Reset
Cancel


Rock Properties
X
Enter Rock Properties for Layer 2:
Default
Absolute Permeability (md):
100
(equal to absolute k)
Endpoint Oil Permeability (md):
(0.2)
Porosity:
Layer Thickness (ft):
(0.3)
Residual Oil Saturation (Sor):
20
Please Check One
Water Zone
Oil Zone
X
Previous Layer
Finish
Reset
Cancel


Gelant Volume Calculation
X
Default (10%)
Target Final Oil Productivity Loss (%):
Downhole Pressure Drop After Treatment (psi):
Same as Before Treatment
Brine Residual Resistance Factor (Frrw):
10100
Oil Residual Resistance Factor (Frro):
14
Calculate gelant volume required?
Yes
Reset
Previous
Cancel


Gel Design
Calculate Gelant Volume Required
Back Calculate Frrs from Field Data
Previous
Cancel

STOP

X

This is not a good candidate well (J/Jo < 5).

SUGGESTION: You might try a significantly lower down hole pressure drop (before the treatment).

OK

Treatment Design

X

Treatment-Design Parameters

Target Oil Productivity Loss (%) 10

Brine Residual Resistance Factor (Frrw) 10100

Oil Residual Resistance Factor (Frro) 14

J/Jo Before Treatment 9

Volume of Gelant Required (bbl) 4152

Treatment Results

	Before Treatment	After Treatment
Total Production Rate (bbl/D) =	1010	45.5
Producing Water Oil Ratio (WOR) =	100	4.1
Oil Production Rate (bbl/D) =	10	9
Water Production Rate (bbl/D) =	1000	36.5

Previous | Print | Next Case | Sensitivity Analysis

Restart | Exit

Sensitivity Analysis

Effect of Amount of Gelant Injected

Effect of Frrw and Frro

Previous Page

Next Case

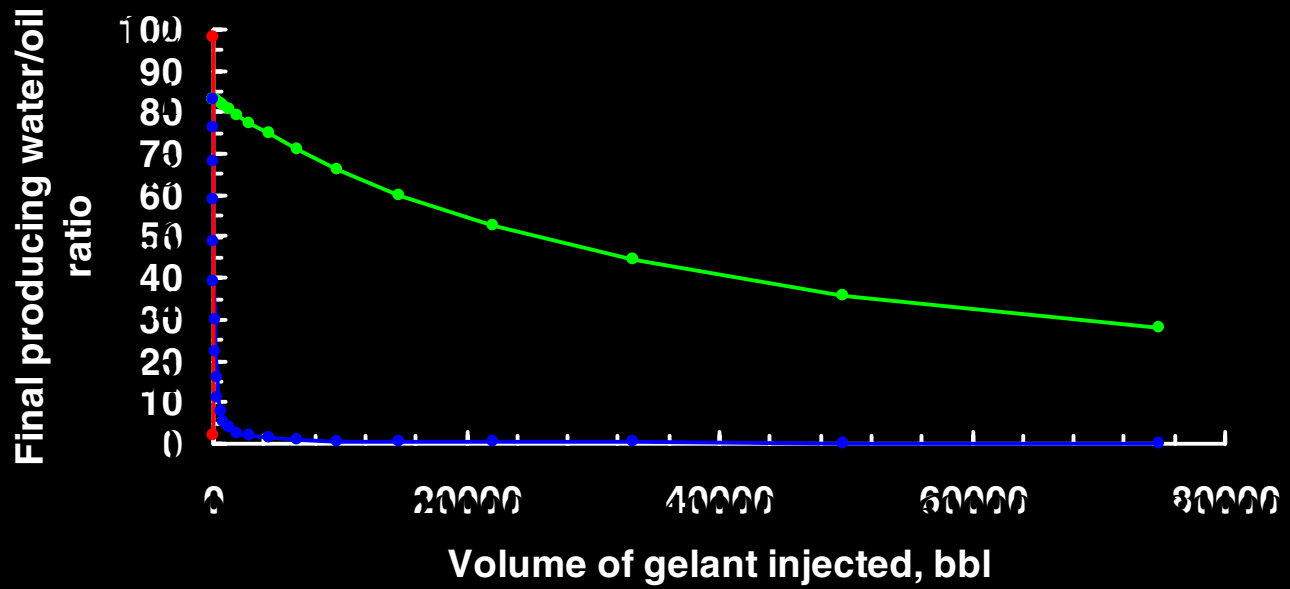
Restart

Exit Program

Effect of Gelant Volume on Treatment Results

X

Effect of Gelant Volume on WOR and Oil Productivity Loss



Final WOR Oil productivity, final/initial Your design

Frrw = 10100 Frro = 14

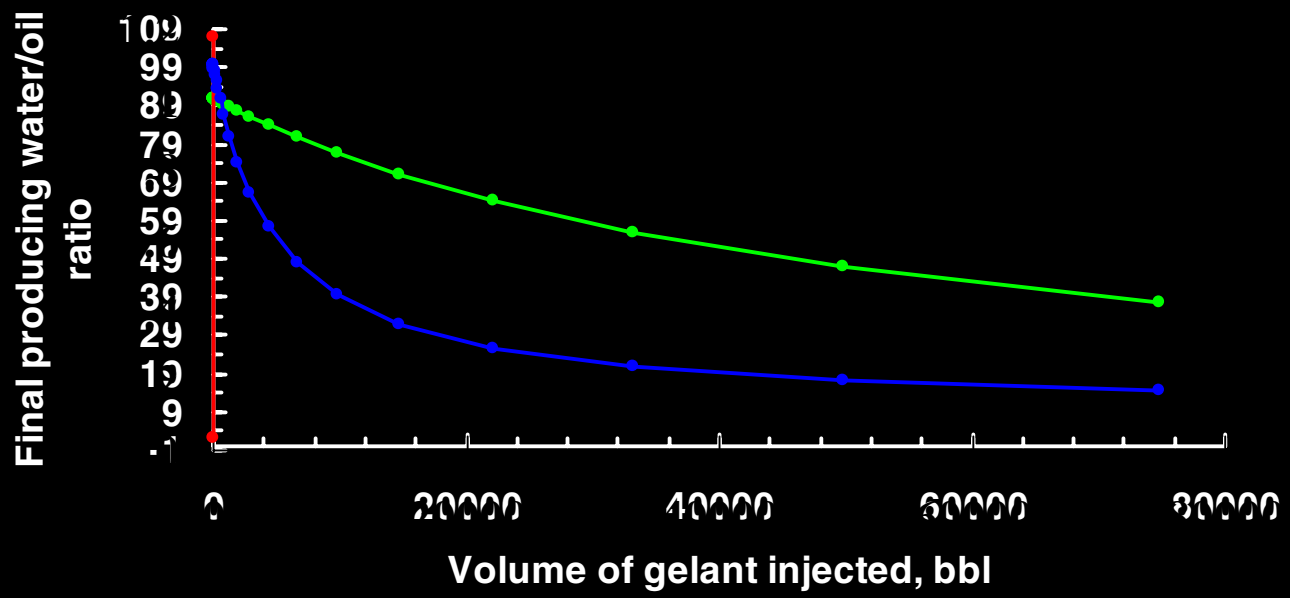
Your design (bbls of gelant) = 4152

Previous Print Exit

Effect of Frrw and Frro

X

Effect of Frrw and Frro on WOR and Oil Productivity Loss



Final WOR Oil productivity, final/initial Your design

Frrw = 100 Frro = 10

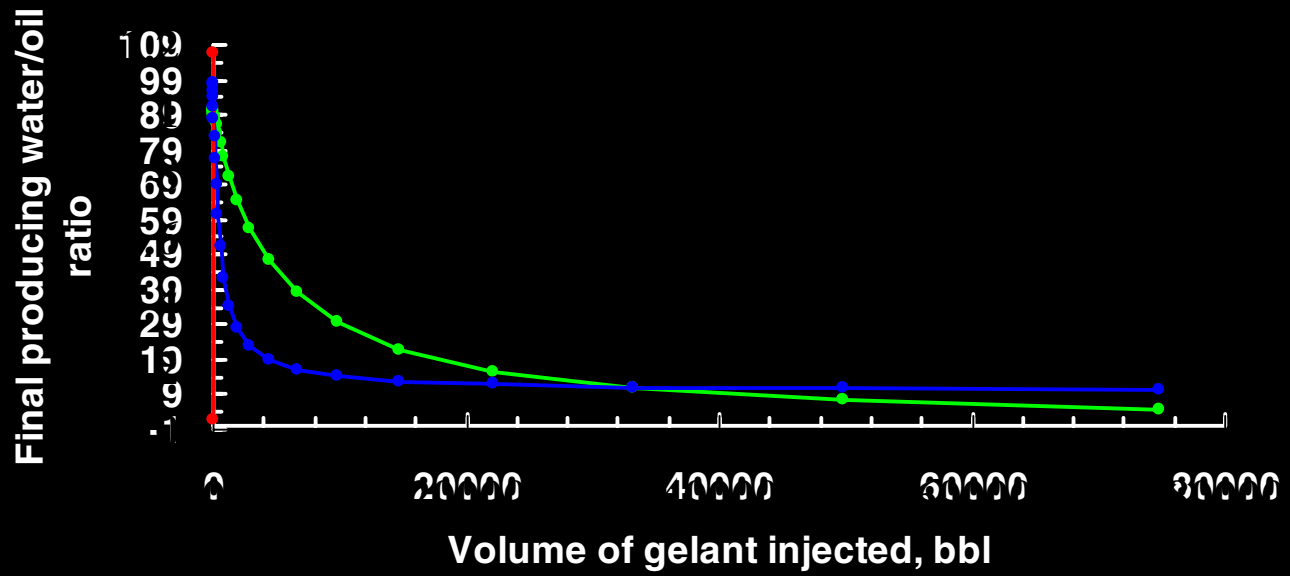
Your design (bbls of gelant) = 5997

Previous Print Exit Update Design

Effect of Frrw and Frro

X

Effect of Frrw and Frro on WOR and Oil Productivity Loss

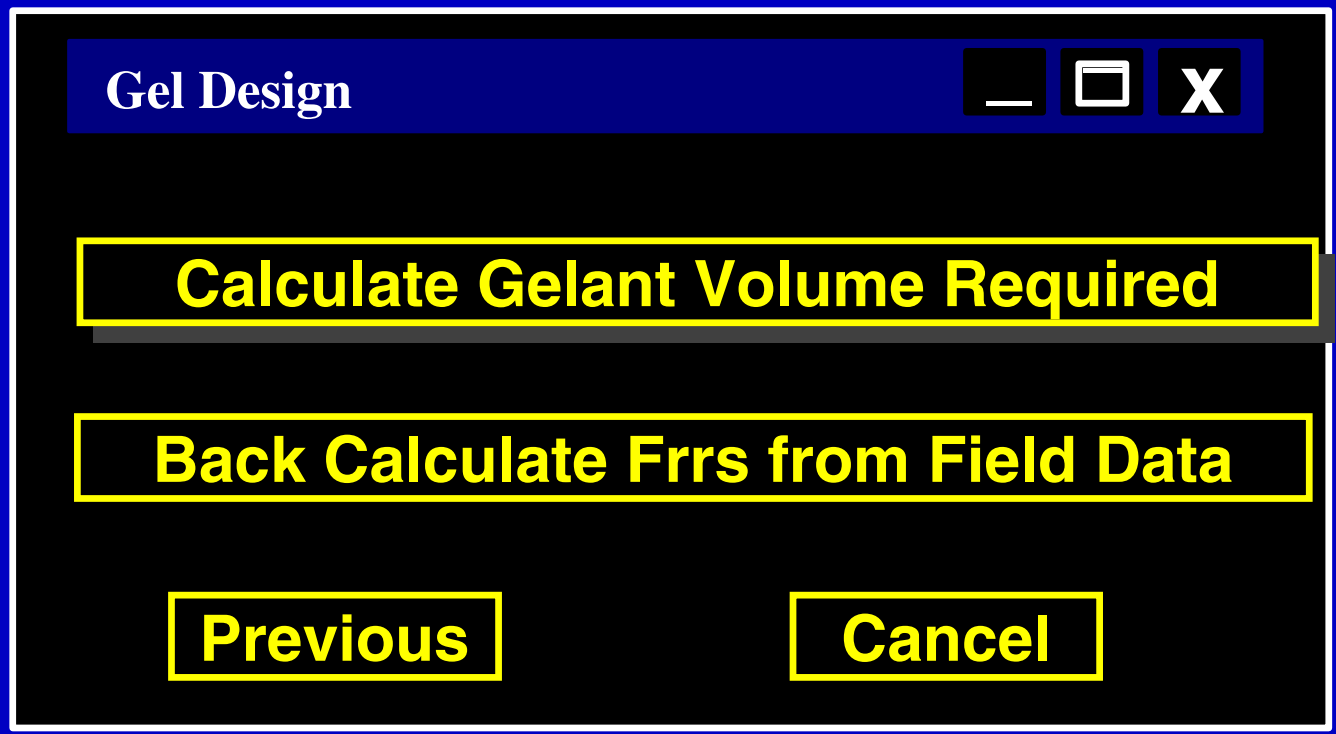


Final WOR Oil productivity, final/initial Your design

Frrw = 1000 Frro = 100

Your design (bbls of gelant) = 545

Previous Print Exit Update Design


Gel Design
Calculate Gelant Volume Required
Back Calculate Frrs from Field Data
Previous
Cancel

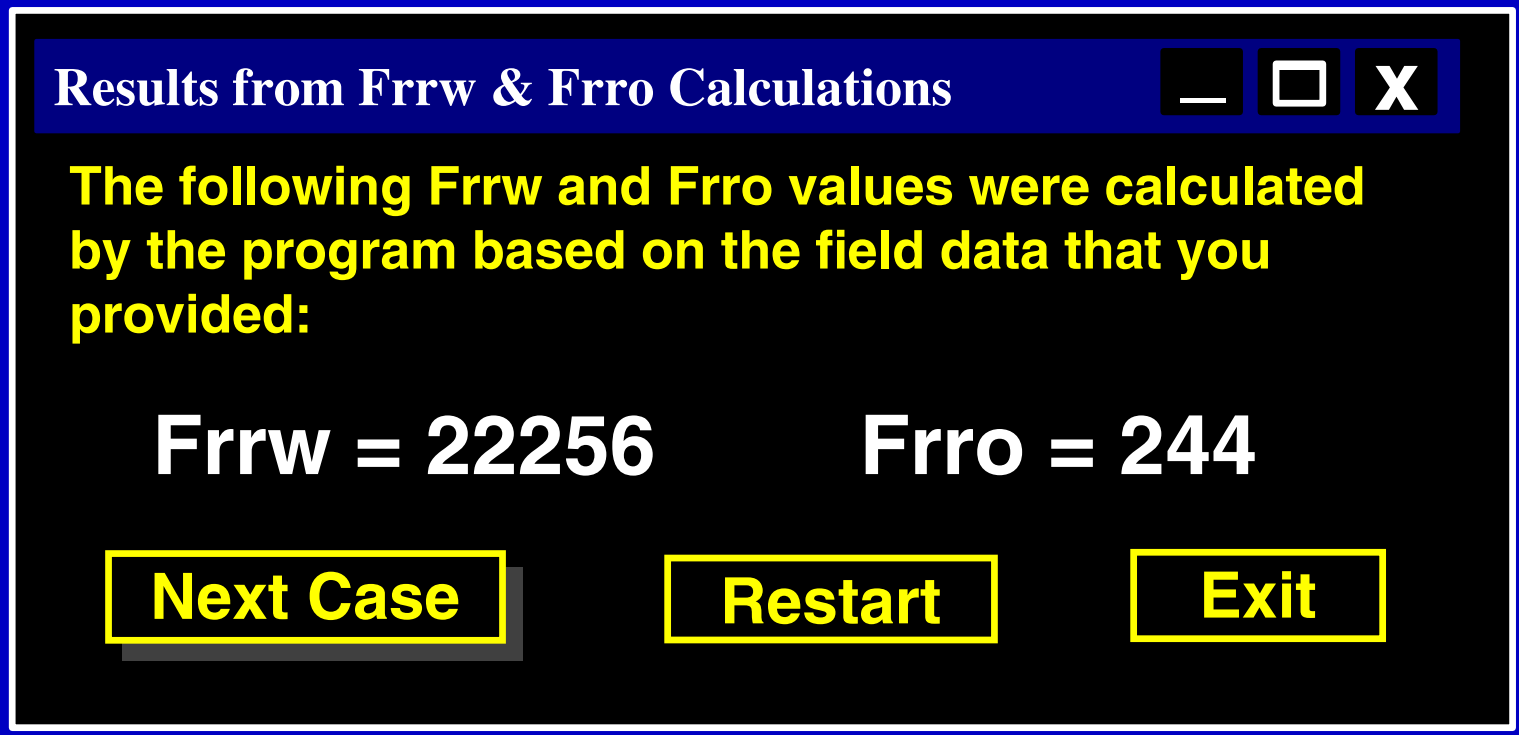
Frrw & Frro Calculations From Field Data

Please provide the following data:

Volume of Gelant Injected (bbls)	1000
Oil Production Rate After Treatment (BOPD):	200
Water Production Rate After Treatment (BWPD)	150
Downhole Pressure Drop After Treatment (psi):	

Calculate Frrw and Frro? Yes Reset

Previous Exit


Results from Frrw & Frro Calculations
The following Frrw and Frro values were calculated by the program based on the field data that you provided:
Frrw = 22256
Frro = 244
Next Case
Restart
Exit

CONCLUSIONS

- A procedure has been developed to size gelant treatments in hydraulically fractured production wells.
- The procedure has been incorporated in user-friendly graphical-user-interface software.
- In the absence of water and oil residual resistance factors, the method can be used to calculate in-situ Frrw and Frro values.
- To properly use and test the procedure, Frrw and Frro values must be determined from laboratory corefloods or from in-situ values from a nearby field application.